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# PROCEEDINGS

## AMERICAN SOCIETY OF CIVIL ENGINEERS

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# DISCUSSION OF PROCEEDINGS - SEPARATES

454, 471, 472, 557

SANITARY ENGINEERING DIVISION

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Discussion of
"NEW YORK'S EXTENSION OF
ITS SOURCES TO THE DELAWARE"

by Karl R. Kennison
(Proc. Sep. 454)

SAMUEL A. GREELEY,[1] Hon. M. ASCE.—The paper by Mr. Kennison in Separate No. 454 under the title "New York's Extension of Its Sources to the Delaware" is a noteworthy contribution descriptive of a large water project and will be useful to many. The four figures attached to the paper are exceptionally well done.

Parts of the paper depart from the title and relate to the case settled in June, 1954 by the Supreme Court of the United States and these parts, in the writer's opinion, are too limited to give the reader a fair and adequate understanding of the interstate problem resulting from New York's petition to divert additional water from the natural drainage basin of the Delaware River.

On page 8 of the Separate, Mr. Kennison quotes the following paragraph which, the writer believes, is taken from a press release and which is said by Mr. Kennison to be a tentative agreement between the States:

> "It is now possible for all parties to make certain recommendations to the Special Master. . . . . In consideration of the increased capacity of the lower Basin resulting from the modified release formula thus offered by New York, New Jersey and Pennsylvania will not oppose the proposed diversions by New York. . . . . In flood times, there is more than enough water in the Delaware for everyone. In seasons of abnormally low flow, the releases which New York has agreed to make will be a great boon to the Lower Delaware. In the opinion of the engineers for Pennsylvania and New Jersey the additional diversion by New York City under its enlarged plan of development will, if conditions do not change, have no adverse effect on the interests of Pennsylvania and New Jersey, but on the contrary will further such interests by increasing the quantity of water available to those States."

In the writer's opinion, this is an incomplete and, therefore, inadequate account of the Delaware River problem as found in the records of the case and seems to the writer to give an impression not in accord with Pennsylvania's real attitude. There are other more authentic, pertinent, and worthy sources of information for the views of New York, New Jersey, and Pennsylvania. The following documents are especially important:

> "1. The report of the Special Master, Charles N. Burch, in the 1930 case.
>
> "2. The opinion and decree of the Supreme Court of the United States in the 1930 case.

1. Partner, Greeley and Hansen, Engrs., Chicago, Ill.

"3. The report of the Special Master, Kurt F. Pantzer, in the 1952 case.

"4. The decree of the Supreme Court of the United States in the 1952 case."

These documents taken with the petitions, answers, testimonies, and briefs of record in the two cases, are a competent, fair, and clear statement of the problem. For the present status, the report of the Special Master and the decree are, of course, supreme.

As a matter of fact, there was placed in the record a statement by Pennsylvania which gives its views much more completely and correctly than the quotation from Mr. Kennison. The following are pertinent quotations from this Pennsylvania statement, dated June 22, 1953:

"4. Pennsylvania insists, and New York and New Jersey concede, that the modified decree of the Supreme Court should continue its existing provisions that the takings by New York and New Jersey shall not be deemed prior appropriations; that they shall not be deemed adjudications in perpetuity of the fair and equitable shares of New York and New Jersey of the water of the Delaware River and that no party shall be estopped from asking for a review of the terms of the decree to be entered, upon a showing of changed conditions, and that such decree shall reiterate paragraph '6' of the original decree to wit:

'6. Any of the parties hereto, complainant, defendants or intervener, may apply at the foot of this decree for other or further action or relief and this court retains jurisdiction of the suit for the purpose of any order or direction or modification of this decree, or any supplemental decree that it may deem at any time to be proper in relation to the subject-matter in controversy.'"

The foregoing paragraphs illustrate that limited comment on the Delaware River problem is more likely to be misleading than clarifying. The problem is difficult to summarize in a brief statement and particularly in a statement which is part of the description of a construction project.

In Separate No. 454 Mr. Kennison also describes the procedure established by Special Master Kurt F. Pantzer regarding the submission and review of testimony. This proved to be a good method which, the writer thinks, much reduced the time required to reach a conclusion of the case.

Discussion of
"INCINERATION AND ALTERNATIVE
REFUSE DISPOSAL PROCESSES"

by Ralph Stone and F. R. Bowerman
(Proc. Sep. 471)

SAMUEL A. GREELEY,[1] Hon. M. ASCE.—The paper by Mr. Stone and Mr. Bowerman which appeared as Separate No. 471 of the Proceedings of the Society under the title "Incineration and Alternative Refuse Disposal Processes" is a noteworthy contribution to one of the more difficult problems in the field of sanitary engineering. It is well summarized in twenty paragraphs on pages 20 and 21. The subject is so comprehensive that a competent discussion which must necessarily be brief cannot be made. It should, however, be noted that refuse disposal processes need careful consideration and application for each locality. Some comments follow which illustrate the need for an understanding of the relation between general statements and their application in detail to specific problems.

It seems clear that refuse disposal will be different in different cities and in different parts of large cities and that this depends in the first place upon what is meant by the term "refuse" and upon the characteristics of the refuse to be disposed of. What, for instance, is the significance of the four main headings of Figure No. 2. The writer's understanding is that mixed refuse is that resulting from a single collection and generally comprises garbage and combustible rubbish, but sometimes includes noncombustible rubbish and ashes as well. The writer thinks the term "rubbish" or "trash" is used more often for the material referred to in Figure No. 2 as combustible "refuse." Differences in the characteristics of refuse are important in studies relating to the application of disposal processes.

Item 3 in the Summary states that transfer stations can be employed for reducing the costs of transporting refuse. This is generally true but in detail for a particular locality the kind and cost of a transfer station, suitable to its location, is important. The one in Washington shown on Figure 3 cost almost $1,000,000 several years ago. The local requirements may well require a greater expenditure for transfer stations than has been made in the past and this in turn will affect the relative costs of disposal by land fill including the haul to the site, and of incineration.

Items 8, 9, and 10 describe some general details of incineration plants. It is doubtful that two-level topography will much reduce construction costs for a crane and bin plant. The present availability of cranes which lift at relatively high speeds make level sites practicable and economical. Whereas some years ago crane lifts were limited to about 60 feet, this lift may be increased now to as much as 80 feet.

There has always been a hope that revenue could be obtained by the use or sale of by-products, but there have been few local situations where salvage has proved to be worth-while.

1. Partner, Greeley and Hansen, Engineers, Chicago, Ill.

In the writer's practice, it has been difficult to obtain construction costs as low as $2,000 per ton of rated capacity. The range, in general, is from $3,000 to $4,000. In the writer's experience the total annual cost including actual operating cost and debt service is likely to range from $3.00 to $4.00 per ton of refuse burned.

Reference is made in the paper to the fact that the actual quantity burned does not often equal the rated capacity and that it will be wise to establish more realistic design criteria. This, of course, is true, but the application depends upon how the rated capacity is obtained. The writer thinks that an incinerator should be designed for an estimated maximum weekly quantity of refuse at some date, perhaps twenty years, in the future. On this basis and with the correct selection of furnace units, there will be opportunity during months of lower refuse quantities to accomplish a good deal of maintenance work. Reference to Figure No. 5 indicates that the difference between the unit costs at say, 85 per cent of utilization is not very much more than for use at rated capacity.

The thermodynamic calculations on pages 15 through 19 are a helpful illustration. Such calculations can be used to show the importance of the characteristics of the refuse.

Refuse having different characteristics may be illustrated as follows:

| Item | Stone and Bowerman | Greeley and Hansen |
|---|---|---|
| Composition of Refuse—% by Weight | | |
| Combustibles | 50 | 60 |
| Water | 40 | 15 |
| Ash | 10 | 25 |
| Composition of Combustibles—% by Weight | | |
| Carbon | 44.4 | 52 |
| Hydrogen | 6.2 | 6 |
| Oxygen | 49.4 | 40 |
| Other | 0 | 2 |
| Heating Value of Combustibles | | |
| B.t.u. per lb. | 9,600 | 9,600 |
| Heat Losses by Conduction and Incomplete Combustion | | |
| % of Total | 7 | 7 |
| Gaseous Products of Combustion for a combustion chamber temperature of 1,650° F. | | |
| Lbs. per lb. of refuse | 8.66 | 10.86 |
| Cu. ft. per lb. of refuse @ 1,650° F. | 460 | 580 |

In the writer's experience, a refuse containing 40 per cent of moisture and 10 per cent of ash is not common, even for a mixture of garbage and combustible rubbish. It is likely that the percentage of ash and water will be somewhat higher. The composition in the column headed "Greeley and Hansen" is applicable to rubbish, although some of the time the percentage of ash might be somewhat lower. The writer usually considers somewhat greater heat losses than 7.0 per cent. The tabulation shows the quantity of gaseous products of combustion amounting to 460 cubic feet in accordance with the Stone and Bowerman calculations and 580 cubic feet per pound of refuse at 1,650 degrees F. for the assumed Greeley and Hansen refuse. This is a considerable difference when considering fly ash removal facilities. A considerable range in characteristics should be used in the calculations to cover changes in the refuse caused by weather and other conditions.

The reference in Item 15 of the Summary is good. The cost of construction and the life of the furnace depend on the refractories used as well as the operating cost. The writer thinks that a suspended arch construction for the roof and sectionally supported walls are likely to be economical in the long run.

Item 17 of the Summary makes a good point as it seems unnecessary to limit the residual organic matter to very small amounts at considerable additional cost.

The writer has the impression from the paper that the authors believe that a competent study of a local situation will result in more frequent use of the sanitary fill method of disposal. The writer is in accord with this general objective but he has been somewhat surprised at the difficulty of accomplishing the simpler method of disposal. In large cities a combination of methods for the disposal of garbage and rubbish works out to be favorable if sites can be obtained. For both Chicago and for Cook County outside of Chicago, the writer's firm has developed general plans which include loading or transfer stations, incinerators, and sanitary fills for refuse comprising mainly garbage and rubbish with some household ash.

In recent years there has been a growing demand for careful and competent engineering studies related to local conditions. The paper by Messrs. Stone and Bowerman appearing as Separate No. 471 is a worthy contribution to this complex and difficult problem.

Discussion of
"INFILTRATION GALLERIES"

by Ralph Stone
(Proc. Sep. 472)

DAVID K. TODD,[1] J.M. ASCE.—Of all problems in the water supply field, one of the most interesting is that of obtaining fresh water on small islands surrounded by sea water. Most oceanic islands are relatively permeable, consisting of sand, lava, coral, or limestone, so that sea water is everywhere present at some depth below ground surface. Under such conditions, the infiltration gallery has enabled man on islands around the world to obtain adequate fresh water. By collecting with a minimum of disturbance or drawdown fresh ground water, which comes from rainfall and floats on top of the denser sea water, an infiltration gallery uniquely satisfies island water needs. The writer would like to augment the comprehensive summary which the author has presented on the use of galleries by mentioning a few installations for island water supplies.

As pointed out by Mr. Stone, infiltration galleries are used on the Hawaiian Islands for water supply. In the comprehensive ground-water investigations on the island of Oahu by Stearns,[2,3,4] these galleries were referred to as Maui-type wells. Originated more than 50 years ago to irrigate sugar cane, they have successfully proven their effectiveness. The basic design consists of a vertical or inclined shaft to the ground-water table, a pump room and sump, and one or more horizontal infiltration tunnels feeding into the sump. With the tunnel invert located just below the water table, supplies are obtained with drawdowns of from a few inches to several feet. Infiltration galleries presently supply not only plantations, but also United States Army and Navy installations and public water supplies. Wentworth[5] reported a total of 48 galleries in the Honolulu-Pearl Harbor area of Oahu alone.

The impact of World War II on the Pacific area created greatly increased water supply needs. Infiltration galleries have provided necessary supplies for several of the Marianas Islands.[6] On Guam in 1945 the Seabees built a

1. Assistant Professor of Civil Engineering, Univ. of California, Berkeley.
2. Stearns, H.T. and Vaksik, K.N., Geology and Ground-Water Resources of the Island of Oahu, Hawaii, Bull. 1, Div. of Hydrography, Terr. of Hawaii, 1935, 479 pp.
3. Stearns, N.D., Wells for the Water of Hawaii, Engineering News-Record, v. 118, 1937, pp. 450-452.
4. Stearns, H.T., Supplement to the Geology and Ground-Water Resources of the Island of Oahu, Hawaii, Bull. 5, Div. of Hydrography, Terr. of Hawaii, 1940, 164 pp.
5. Wentworth, C.K., Geology and Ground-Water Resources of the Honolulu-Pearl Harbor Area, Oahu, Hawaii, Board of Water Supply, City and County of Honolulu, Honolulu, 1951, 111 pp.
6. Ohrt, F., Water Development and Salt-Water Intrusion on Pacific Islands, Jnl. Amer. Water Works Assn., v. 39, 1947, pp. 979-988.

gallery to produce 2 to 3 mgd.[7,8] A shaft was cut on a 30-degree angle for 126 feet to intersect the water table. The pump room was excavated to provide an area of more than 450 square feet. Two galleries, each 150 feet long, 9 feet high, and 7 feet wide, were projected horizontally outward into the coral to collect the top two feet of fresh water. Since that time a second and larger gallery was constructed to meet expanding water requirements.[9]

North of Guam in the Marianas group lies Tinian Island. Here too, the Seabees provided a water supply with infiltration galleries, using a unique construction procedure.[10] Because of the shallow depth to the ground-water table, a 300-ft trench was dug in the coral limestone to intersect the water table. Double lengths of 20-inch diameter perforated tubes (salvaged from steel incendiary bomb crates) were laid in the trench. A suction pit (constructed of standard Navy pontoons) was located midway in the trench, and the trench was backfilled with crushed coral and capped with clay. Pumping tests produced a drawdown in the suction pit of only 5 inches at a rate of 2 mgd.

Islands of the Atlantic Ocean are plagued with the same problem of obtaining fresh water in close proximity to salt water. The early work of Herzberg, co-founder of the Ghyben-Herzberg relation expressing the balance between fresh and salt subsurface waters, was conducted on the East Frisian Islands in the North Sea off the coast of Germany.[11] And probably the best example of the importance of infiltration galleries for water supply in the Atlantic is that of Bermuda.[12] Water for the city of Hamilton is obtained from numerous small-diameter open-joint tile pipes which are placed in the limestone in contact with the shallow fresh-water lens. The pipes connect with a concrete sump from which the water is pumped to a treatment plant before use.

In contrast with the previous examples, the water supply for Nassau on New Providence Island, Bahama Islands, formerly came from conventional wells.[13] The difficulties encountered reflect to the advantage of infiltration galleries. Usual unfavorable geologic conditions, namely porous rock and salt water only 25 to 30 feet below mean sea level, limit fresh water supplies. To obtain sufficient fresh water and to avoid coning of salt water in wells, a large battery of widely spaced wells was necessary. Water was pumped intermittently at minimum rates from various groups of wells. Estimates based upon available water from rainfall placed the maximum average safe pumping rate at about 2 gpm per well. Actual rates exceeded this, but

7. Abplanalp, G. H., Ground-Water Development on Guam, Engineering News-Record, v. 135, No. 10, 1945, pp. 317-319.
8. Washbourne, J. L. and Moore, N. H., Tunneling for Fresh Water on Guam, Civil Engineering, v. 15, no. 11, 1945, pp. 510-512.
9. Fil, J. F., Horizontal Wells Reduce Salt-Water Intrusion into Guam's Water Supply, Civil Engineering, v. 20, no. 7, 1950, pp. 32-33.
10. Lawlor, J.P., Skimming Trench Solves a Coral Island Water-Supply Problem, Engineering News-Record, v. 136, 1946, pp. 83-85.
11. Herzberg, B., Die Wasserversorgung einiger Nordseebader, Journal fur Gasbeleuchtung und Wasserversorgung, v. 44, 1901, pp. 815-819, 842-844.
12. Mitchell, P.E., Bermuda Unique Water System, Water Works Engineering, v. 101, no. 10, 1948, pp. 942-945.
13. Riddel, J. O., Excluding Salt Water From Island Wells—A Theory of the Occurrence of Ground-Water Based on Experience at Nassau, Bahama Islands, Civil Engineering, v. 3, 1933, pp. 383-385.

intermittent daily and seasonal operations reduced the average to near this figure. An infiltration gallery under these circumstances would be expected to furnish at lower cost a more dependable island water supply. The writer believes that the foregoing information supports and strengthens the author's conclusions.

Discussion of
"STATE ACTIVITIES AND FISCAL ASPECTS: REPORT OF A SUBCOMMITTEE OF THE COMMITTEE ON REFUSE COLLECTION AND DISPOSAL OF THE SANITARY ENGINEERING DIVISION"

(Proc. Sep. 557)

CORRECTIONS.—At the bottom of page 1, the name of Charles L. McGauhey should be changed to P. H. McGauhey. This error also should be corrected on page 1 of the following separates: 473, 474, 496, 497, 498, 556.

## PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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c. Discussion of several papers, grouped by Divisions.
d. Presented at the Atlanta (Ga.) Convention of the Society in February, 1954.
e. Presented at the Atlantic City (N.J.) Convention in June, 1954.

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